

ABSTRACT

In one aspect the invention provides a method for laser induced breakdown of a material with a pulsed laser beam where the material is characterized by a relationship of fluence breakdown threshold (F_{th}) versus laser beam pulse width (T) that exhibits an abrupt, rapid, and distinct change or at least a clearly detectable and distinct change in slope at a predetermined laser pulse width value. The method comprises generating a beam of laser pulses in which each pulse has a pulse width equal to or less than the predetermined laser pulse width value. The beam is focused above the surface of a material where laser induced breakdown is desired. The region of least confusion (minimum beam waist or average spot size) is above the surface of the material in which laser induced breakdown is desired since the intensity of the beam falls off in the forward direction, preferably the region of the beam at or within the surface is between the region of least confusion and sufficient to remove material and the minimum intensity necessary for laser induced breakdown of the material to be removed, most preferably the region of minimum intensity is disposed at the surface of the material to be removed. The beam may be used in combination with a mask in the beam path. The beam or mask may be moved in the x, y, and Z directions to produce desired features. The technique can produce features smaller than the spot size and Rayleigh range due to enhanced damage threshold accuracy in the short pulse regime.

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